JASEM ISSN 1119-8362

Full-text Available Online at www.ajol.info and www.bioline.org.br/ja

J. Appl. Sci. Environ. Manage. *Dec.* 2016
Vol. 20 (4) 1191-1197

Effect of diesel generator exhaust pollutants on growth of *Vinca rosea* and *Ruellia tuberosa*

[1] NAMRA ZAFAR; [1, 2, *] MOHAMMAD ATHAR; [1] MUHAMMAD ZAFAR IQBAL; [1] MUHAMMAD SHAFIQ

[1] Department of Botany, University of Karachi, Karachi- 75270, Pakistan
[2] California Department of Food and Agriculture, 3288 Meadowview Road, Sacramento, CA 95832, U.S.A.
(Corresponding Author[*])

ABSTRACT: The effects of exhaust pollutants of generator on root and shoot length, root and shoot weight, number of leaflets and leaf area, leaf and total plant dry weight of *Vinca rosea* and *Ruellia tuberosa* were studied. The treatment of exhaust pollutants produced significant effects on root, shoot growth, number of leaflet and leaf area of *V. rosea* and *R. tuberosa* as compared to control. The exhaust emission treatment decreased seedling dry weight of *V. rosea* and *R. tuberosa.* The data showed that the exhaust emission significantly decreased the number of leaflet and leaf area for both species viz. *V. rosea* and *R. tuberosa* as compared to control. A significant decrease in the seedling growth performances of *V. rosea* and *R. tuberosa* resulted in decrease in seedling dry weight and showed that the exhaust treatment affects the seedling dry weight performance as compared to control treatment. It was found that the treatment of exhaust emission from a portable powered generator fueled negatively affected the seedling growth of *V. rosea* as compared to *R. tuberosa*. The findings may be helpful for plantation in polluted area.

http://dx.doi.org/10.4314/jasem.v20i4.35

***Key words**:* Biomass, diesel generator, exhausts emission, leaf area, pollutant, seedling growth, *Ruellia tuberosa, Vinca rosea,*

The environment related issues in Pakistan are increasing due to anthropogenic, industrial and automobile activities. An exponential increase in energy demands in all segments of societies also increased. The use of alternate energy resources due to shortage of electricity has become an important issue since last few years very rapidly. The use of petrol engine generator at homes, offices and shops is one of the rising demands of every one to overcome the shortage of electricity. By the running of these generator a large amount toxic pollutants likewise, carbon dioxide, carbon monoxide, sulfur dioxide, oxides of nitrogen, formaldehyde, hydrocarbons of different molecular weight and ammonia are released in the environment. The direct contact of these pollutants creates adverse consequences on human health as well as on plants life. The exhaust of pollutants could cover the leaf surface resulting in the reduction of plant growth. The clogging of stomatal pores and changes in gas exchange ability of leaves is commonly reported in literature.

Plants in house and outside the house are consider as an atmosphere cleaner so could be affected by exhaust fumes and smoke discharge from the generator. Previous research has shown that at high concentrations many of the pollutants present in exhaust gases can be damaging to plants (Ackerly and Bazzaz 1995, Adam and Duncan, 1999, Grantz et al., 2003, Weil and Schaub 1999). Gratani et al., (2000) found that although the foliage of *Quercus ilex* trees had a reduced life span following exposure to high combustion emission in Rome, this was compensated by higher stomatal conductance, chlorophyll content and photosynthetic activity. Leaf surface characteristics were affected with less chlorophyll content during combustion, other pollutants, including Sulphur dioxide and volatile organic compounds, are emitted together with carbonaceous particles from incompletely burnt fuel droplets (Colvile et al., 2001). There is also evidence that that plant species affected from vehicular emission stresses. A significant decline in leaf growth of *Alstonia scholaris* and *Pongamia pinnata* was investigated at M.A. Jinnah road, Karachi, city (Shafiq and Iqbal, 2003). The reduction in leaf growth of some roadside plants was the witness of bad effects of the pollutant discharged from the automobile activities (Iqbal and Shafiq 1999, Shafiq and Iqbal 2005, 2012; Shafiq et al., 2009). The diesel engine is the most efficient prime mover commonly available today and generates electricity more

economically than any other device in their size range. But the diesel is one of the largest contributors to environmental pollution problems worldwide, and will remain so, with large increases expected in vehicle population and vehicle miles traveled (VMT) causing ever-increasing global emissions (Lloyd and Cackette 2001). The combustion of fossil fuels is the main culprit in increasing the global carbon dioxide (CO_2) level, a consequence of global warming (Nwafor 2004). Diesel emissions are chemically complex and quite variable and they included both as phase and particulate emissions. The emission of PAH compounds from the incomplete combustion of diesel fuel depended greatly on the source of the fuel and the driving patterns (Borras et al., 2009). One of the most severe ecological problems nowadays is the contamination of environment, particularly water basins, with petroleum and petroleum products (Valev et al., 2011). In recent years the demands for energy have grown very quickly due to the rapid development of certain growing economics, especially in Asia and the Middle East (Shirneshana 2013). Diesel burning engines are common in many automobiles, generators, heavy duty vehicles, and locomotives. The exhaust emitted by these engines contains a large number of chemicals and gases as well as heavier particulate matter that can be inhaled through the lungs. These chemicals include nitrous oxide, nitrogen dioxide, formaldehyde, benzene, nickel, sulfur dioxide, hydrogen sulfide, carbon dioxide, and carbon monoxide, all of which can have significant negative health effects (Wolf 2014).

Scientific data about the environmental impact of exhaust pollutants produced by combustion of diesel petrol oil are scare. The effects of generator exhaust emission derived from engine on the seedling growth performance of two different plants species namely, *Vinca rosea* and *Ruellia tuberosa* was selected for the present experimental research.

MATERIALS AND METHODS

Species description: Vinca rosea and *Ruellia tuberosa* species are extensively cultivated as a flowering evergreen attractive ornamental plant. These plant species are often used in garden and houses. They are also traditionally used as an evergreen maintenance free ground cover, many cultivars are available with different plant, leaf and flower colors, site and habits. *Vinca* plants have slender trailing stems 1-2 m long but not growing more than 20-70 cm above ground the stems frequently take root where they touch the ground enabling the plant to spread widely. The leaves are opposite simple broad *R. tuberosa* L. (Acanthaceae) is also known as Minnie, shapegarden root and sheep potato. The species is native of Central Americana but presently been naturalized in many countries of tropical South and South East Asia. *Vinca rosea* (L.) belongs to family Apocynaceae and is an ornamental plant.

*Experimental design***:** The generator used in this experiment was a gasoline run generator of rated power is 2.5 KWh (Kilowatt hour). The output of generator was AC single phase 230 volts whereas its speed was 3000 / 3600. The engine type is 4 stroke single cylinders with cooling system of air dry. The frequency is 50 /60 and fuel tank is 10 liter. It runs on petrol and natural gas whereas lubrication oil is also provided for better performance. To analyze the effects of exhaust pollutants on the growth and development of plants sand culture method was used. The garden soil was obtained from the garden. The dry soil was passed through a 2 mm sieve to remove gravels and other materials. The soil was shifted into plastic pots of 7.3 cm diameter and 9.6 cm in height. At the bottom of pots holes were made. The filter paper was also placed at the bottom to prevent leaching of soil. There were four replicate for each treatment. Experiment was complete randomized. The present work was established during the end of summer season. The seedlings of *V. rosea* and *R. tuberosa* were obtained from garden of a nursery in July, 2013. When all the plants were reached on equal height and size seedling sere selected for experiments in 23 August, 2013. The seedlings were placed in front of generator at a distance of 20 cm. The uniform seedlings of *V. roaea* and *R. tuberosa* were exposed in front of running generator daily for 15 minutes for 30 days. The seedling height (cm), number of leaves and leaf area (cm^2) were recorded after very week. The pots were reshuffled daily to avoid light, shade or any other climatic factor. The plants were irrigated with tap water. After 30 days carefully removed all plant from pots and washed thoroughly with water and measure their root, shoot and seedling length. Root, shoot and leaves were separately placed in oven for drying at 80° C for 24 hours. Oven dried weight of root, shoot, leaves and total plant were recorded. The data obtained were statistically analyzed with t-test at $P<0.05$ level of significance on personnel computer.

RESULTS AND DISCUSSION

The toxic effects of exhaust pollutants of generator on seedling growth of *V. rosea* and *R. tuberosa* were observed (Fig. 1-10). The exhaust emissions contribute to the problems of air, water and soil. The reduction in visibility and effects on vegetation

changes are very common. In a number of comparative studies plants have been exposed to different types of engine petrol, diesel, oil, gas and gasoline and all have found to be the same drastic damages to the plants. In the current study the toxicity of exhaust pollutants has been assessed by means of seedlings growth in soil medium. Soil medium provided different responses of growth under exhaust emission stress therefore the results of this study demonstrated very clear effects on both studied species. The exhaust emission significantly ($p<0.05$) affected the root and shoot growth, number of leaflet, leaf area performance of *V. rosea* as compared to control (Fig. 1-4)

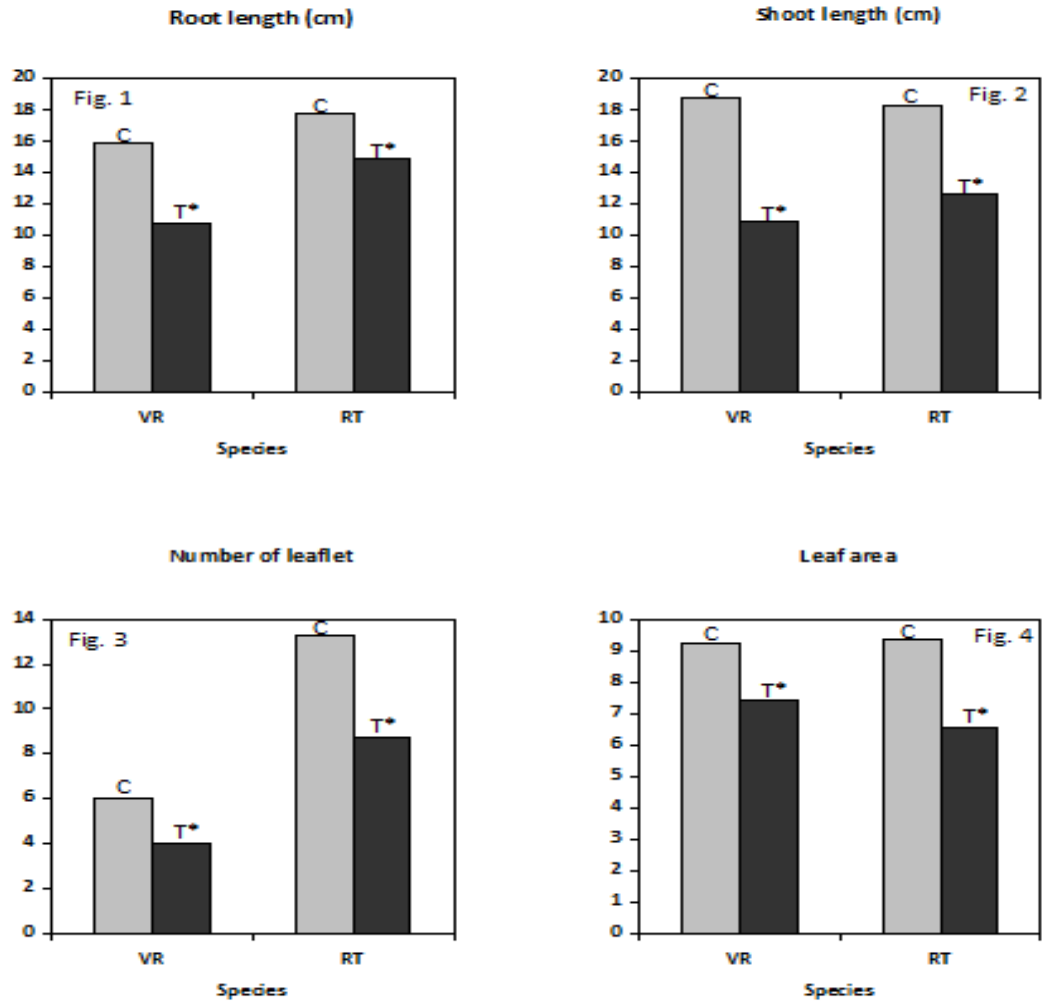

Fig. 1- 4. Effect of exhaust pollutants of generator on root length (cm), shoot length (cm), number of leaflet and leaf area (cm^2) of *Vinca rosea* and *Ruellia tuberosa*.
Symbol used: VR *(Vinca rosea)*, RT, *Ruellia tuberosa*, C (Control), T (Treatment). * An asterisk shows the significant difference from the control at ($p<0.05$).

The exhaust emission exposure also significantly ($p<0.05$) affected the root, shoot, leaf and total plant dry weight of *V. rosea* as compared to control. Similarly, the exhaust emission exposure significantly ($p<0.05$) affected root and shoot length of *R. tuberosa* as compared to control (Fig. 5-8). The number of leaflets and leaf area of *R. tuberose* was also decreased as compared to control. The exhaust emission significantly ($p<0.05$) affected dry mass production such as, root, shoot, leaf and total plant dry weight of *R. tuberosa* as compared to control.

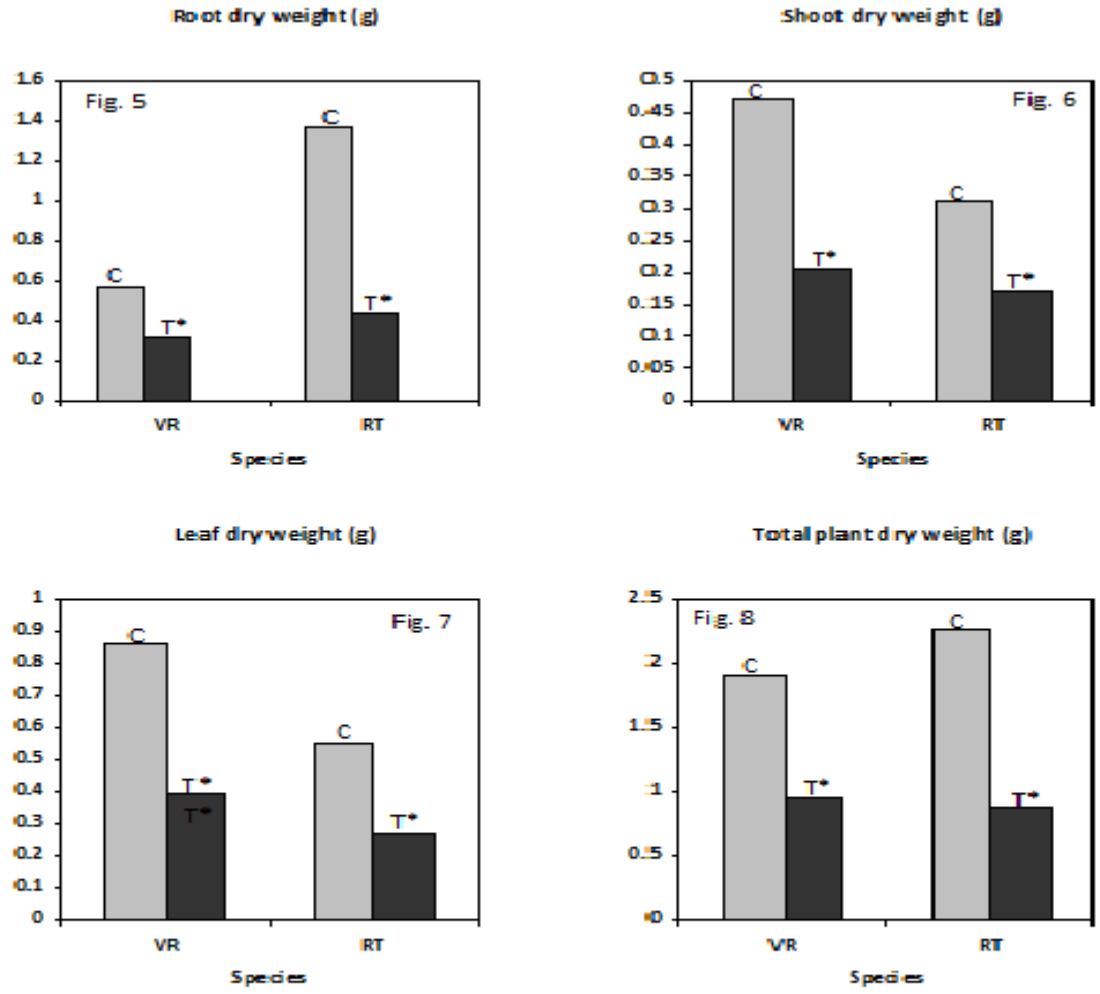

Fig. 5 - 8. Effect of exhaust pollutants of generator on root dry weight (g), shoot dry weight (g), leaf dry weight (g) and total plant dry weight (g) of *Vinca rosea* and *Ruellia tuberosa*
Symbol used: VR *(Vinca rosea)*, RT, *Ruellia tuberosa*, C (Control), T (Treatment). * An asterisk shows the significant difference from the control at ($p<0.05$).

In another investigation, the diesel exhaust soot particles has produced much negative impact on germination and biochemical changes on *Cicer arietinum* over petrol exhaust soot particles and confirmed that the black soot which is originated from vehicle exhaust not only pollutes air but plant community and their physiological pathways affected too (Mondal et al., 2014). Our findings agree with the findings of other researchers who reported that plants with direct contact with exhaust gases showed sever symptoms as compared to plant growing at some distance (Percy et al., 1994). The germination and seedling establishment are vulnerable stages in plant life cycle (Vange et al., 2004). The effects of exhaust emissions exposure from a diesel power generator on seedling growth of *V. rosea* and *R. tuberosa* was observed. Similarly, in another study the treatment of diesel generator at high concentration of NO ranged from 77 nl $^{1-1}$ to 98 nl $^{1-1}$, resulted in species specific changes in growth and phenology of urban wild species, with a constant trend for accelerated senescence and delayed flowering (Bell et al., 2011). Similarly in same types of studies, Houshmandfar and Asli, (2011) reported the effects of mixed gasoline and diesel fuel on seed germination and seedling growth of safflower (*Carthamus tinctorius* L.), and on corn (*Zea mays* L.) used four gasoline and diesel fuel mixture treatments included 0 (control), 20, 40, and 60 ml kg-1 with equal amount of gasoline oil (½) and diesel oil (½). The treatment of mixture concentration of 20 ml kg-1 significantly reduced seedling growth parameter such as shoot fresh

weight, shoot length and root length ($p<0.01$) of safflower and corn.

.

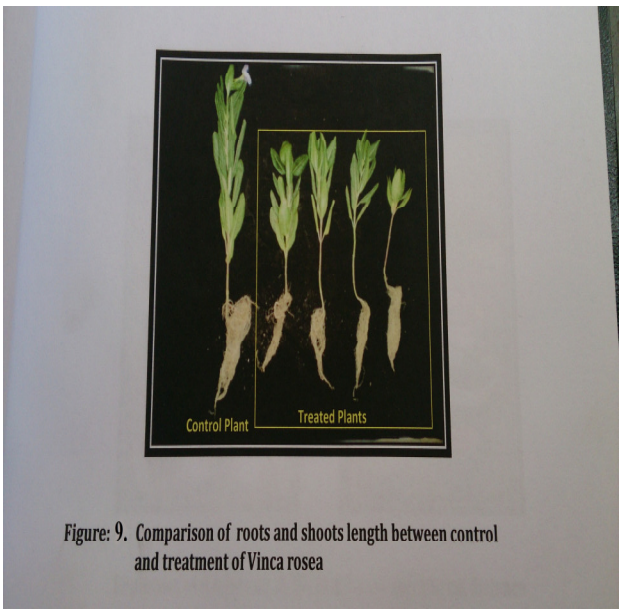

Figure: 9. Comparison of roots and shoots length between control and treatment of Vinca rosea

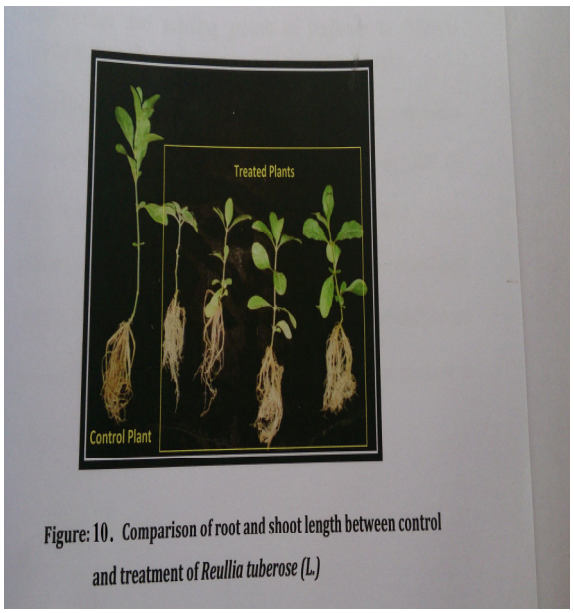

Figure: 10. Comparison of root and shoot length between control and treatment of *Reullia tuberose (L.)*

The visible symptoms on seedlings of *V. rosea* and *R. tuberosa* due to exhaust emission treatment were appeared in the form of leaf chlorosis and early senescence on *V. rosea* and necrotic brown lesion on *R. tuberosa* as compared to control treatment (Fig. 9-10). The seedlings of *V. rosea* and *R. tuberosa* placed in front of generator were found more affected than the seedlings of *V. rosea* and *R. tuberosa* placed at control site.

In *V. rosea* and *R. tuberosa* there was significant difference in the seedling growth performance was observed due to exhaust gas exposure. The reduction in seedling growth could be affected by several reasons and one of them is the presence of toxic pollutants derived from generator. The effects of exhaust pollutants of generator on productivity of *V. rosea* and *R. tuberosa* close to the generator as compared to control seedlings were recorded. Gasoline diesel fuel mixture like the other petroleum products adversely affects the growth and performance of plants (Njoku et al., 2009). In a study the growth performance of *Lolium multiflorum* and *Vicia sativa* showed significant different in diesel fuel contaminated soil. *V. sativa* was reported less affected by diesel fuel and performed better in low levels of diesel fuel contaminated soil than *L. multiflorum* (Adam and Duncan 2003).

Exposure of exhaust emission on plant metabolism disturbance can formed pollution induced stress and resulted in decreased in seedling dry weight production of both species as compared to control. The exposure may provide potential route for the interaction of pollutants though the leaf. Diesel burning engines are common in many automobiles, generators, heavy duty vehicles and locomotives. The exhaust emitted by these engines contains a large number of chemicals and gases as well as heavier particulate matter that can be inhaled. These chemical include nitrous oxide, nitrogen dioxide, formaldehyde, benzene, nickel, sulfur dioxide, hydrogen sulfide, carbon dioxide and carbon monoxide, all of high can have significant negative health effects (Wolf 2014).

In the present study the productivity of plant were significantly reduced with decreased seedling length, root, shoot dry weight and total plant dry weight of both plants as compared to control treatment. As the number of leaf in both treatments and in plants are less compared to control plants. The leaf surface characteristics were affected with less chlorophyll content during combustion emission (Colvile et al., 2001). The direct effects of exhaust on plants and urban ecosystem observed a wide range of effects including growth stimulation and inhibition, changes in gas exchange and premature leaf senescence were detected due to fumigations with NO, NO_2, and their mixture (Bell et al., 2011). The necrotic brown patches was observed in treatment seedlings of *R. tuberosa* the older leaves in *V. rosea* were much

more sensitive to exhaust gas than younger one whereas in *R. tuberose* younger leaves were found more affected.

Conclusions: It is concluded that plants are affected by exhaust emission and long term exposure could be more toxic than short term exposure. *R. tuberosa* showed better resistance to exhaust pollutant than *V. rosea*. The seedling performance of *R. tuberosa* was found better than *V. rosea* which might be due to its resistance to exhaust pollutants. It is also suggested that the plantation of such species eventually results in significant emission reductions and lessen the burden of pollutants of the atmosphere.

REFERENCES

Ackerly, D.D. and F.A. Bazzaz. 1995. Plant growth and reproduction along CO_2 gradients. Nonlinear responses and implications for community change. Global Change Biol., 1: 199-207.

Adam, G. and H.J. Duncan 1999. Effect of diesel fuel on growth of selected plant species. Environ. Geochem. Health, 21: 353-357.

Adam, G. and H.J. Duncan 2003. The effect of diesel fuel on common vetch (*Vicia sativa* L.) plants. Environ. Geochem. Health, 25: 123-130.

Bell, J.N., S.L. Honour and Power, S.A. 2011. Effect of vehicle exhaust emission on urban wild plants species. Environ. Poll., 159: 1984-1990.

Borras, E., L.A. Tortajada-genaro, M. Va'zquez and B. Zielinska, 2009. Polycyclic aromatic hydrocarbon exhaust emissions from different reformulated diesel fuels and engine operation conditions. Atmos. Environ., 43: 5944-5952.

Colvile, R.N., F.J. Hutchinson., J.S. Mindell and R.F. Warren, 2001. The transport sector as a source of air pollution. Atmos. Environ, 35: 1537-1565.

Grantz, D.A., J.H.B. Garner and D.W. Johnson, 2003. Ecological effects of particulate matter, Environ. Internat. 29:213-239.

Gratani, L.M., M.F. Crescente and C. Petruzzi., 2000. Relationship between leaf life span and photosynthetic activity of *Quercus ilex* in polluted urban areas (Rome). Environ. Pollut.110:19-28.

Honour, S.L., J.N.B. Bell., T.A. Ashenden., C.J. Neil and S.A. Power. 2009. Responses of herbaceous plants to urban air pollution: Effects on growth, phenology and leaf surface characteristics. Environ. Pollut. 157(4): 1279-1286.

Houshmandfar, A. and D.E. Asli, 2011. Response of seed germination and seedling growth of Safflower and Corn to gasoline and diesel fuel mixture. Advances in Environ. Biol, **5(1)**: 81-86

Iqbal, M.Z. and M. Shafiq, 1999. Impact of vehicular emission on germination and growth of Neem (*Azadirachta indica*) tree. Hamdard Mediccus, 42: 65-69.

Jank, K. 2014. Air pollution, avoidance behavior and children's respiratory health: Evidence from England. J. of Health Economics, 38: 23-42.

Lloyd, A.C. and T.A. Cackette, 2001. Diesel engines: environmental impact and control. J. Air Waste Manage. Assoc., 51: 809-847.

Mondal, N.K., D. Panja., C. Das., U. Day and K. Das. 2014. Impacts of vehicle exhaust black soot on germination of gram seed (*Cicer arietinum* L.) Comm. Plant Sci 4(1-2): 2237-2240.

Njoku, K.L., M.O. Akinola and B.G. Taiwo, 2009. Effect of gasoline diesel fuel mixture on the germination and the growth of *Vigna unguiculata* (Cowpea), Afr. J. Environ. Sci. Technol., 3: 466-471.

Nwafor, O.M.I. 2004. Emission characteristics of diesel engine running on vegetable oil with elevated fuel inlet temperature. Biomass Bioener., 27: 507-511.

Percy, K.E., J.N. Cape., R. Jagels and C.J. Simpson 1994. Air pollutants and the leaf cuticle", Springer-Verlag, Berlin, pp. 123-138.

Shafiq, M. and M.Z. Iqbal, 2003. Effects of automobile pollution on the phenology and periodicity of some roadside plants, Pakistan J. Bot., 35: 931-938.

Shafiq, M. and M.Z. Iqbal, 2005. The impact of autoemission on the biomass production of some roadside plants, Int. J. Biol. Biotechnol., 2: 93-97.

Shafiq, M. and M.Z. Iqbal, 2012. Impact of Automobile Pollutants on Plants", LAP

LAMBERT Academic Publishing GmbH & Co., Saarbrücken, Germany. 132 pp.

Shafiq, M., M.Z. Iqbal., M. Athar and M. Qayyum**,** 2009. Effects of autoexhaust emission on the phenology of *Cassia siamea* and *Peltophorum pterocarpum*, Afr. J. Biotechnol*.,* 8: 2469-2475.

Shirneshana, A. 2013. HC, CO, CO_2 and NOx emission evaluation of a diesel engine fueled with waste frying oil methyl ester". Procedia – Soc. Behav. Sci*.,* 75: 292-297.

Valente, O.S., V.M.D. Pasa,, C.R.P. Belchior and J.R. Sdre, 2012. Exhaust emissions from diesel power generator fuelled by waste cooking oil biodiesel. The Sci. Total Environ*,* 431: 57-61.

Vange, V., I. Hevchand and Vandvik, V. 2004. Does seed mass and family affect germination and juvenile performance in *Knautia arvensis*?. A study using failure time methods", Acta Oecologica*,* 25: 169-178.

Vlaev, L., P. Petkov., A. Dimitrov and S. Genieva, 2011. Cleanup of water polluted with crude oil or diesel fuel using rice husks ash. J. Taiwan Inst. Chem. Engineers, 42: 957-964.

Weil, M. and H. Schaub, 1999. Influence of exhaust gas and ozone on extracellular peroxidase activity of *Helianthus annus* L. leaves. J. Physiol., 154: 523-528.

Wolf, M. 2014. What are the Health Effects of Diesel Exhaust?", http://www.ehow.com/list_ 6060095 health-effects-diesel-exhaust_.html visited on 25th February, 2014